

MEDICAL SCIENCE IN SIBERIA
OXYGEN EXCHANGE IN THE FAR NORTH

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(NASA-TM-75391) MEDICAL SCIENCE IN SIBERIA: N79-24630
OXYGEN EXCHANGE IN THE FAR NORTH (National
Aeronautics and Space Administration) 6 p
HC A02/MF A01 CSCL 06P Unclass
G3/52 20925

Translation of "Meditsinskaya nauka Sibiri. Osobennosti
kislородного obmena na kraynem severe," Meditsinskaya
Gazeta, 23 August 1978, page 3



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. APRIL 1979

1. Report No. NASA TM-75391	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle MEDICAL SCIENCE IN SIBERIA, OXYGEN EXCHANGE IN THE FAR NORTH		5. Report Date April 1979	
		6. Performing Organization Code	
7. Author(s) V. Kulikov and M. Yegunova		8. Performing Organization Report No.	
		10. Work Unit No.	
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063		11. Contract or Grant No. NASW-3199	
		13. Type of Report and Period Covered Translation	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C 20546		14. Sponsoring Agency Code	
15. Supplementary Notes Translation of "Meditsinskaya nauka Sibiri. Osobennosti kislородnogo obmena na kraynem severe," Meditsinskaya Gazeta, 23 August 1978, page 3			
16. Abstract Differences in oxygen conditions between the native and migrant Siberian population were studied in relation to respiratory function, arterial and venous blood indicators and acid-base indicators. Significant adaptation differences were ascertained between the two populations.			
17. Key Words (Selected by Author(s))		18. Distribution Statement Unclassified-Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 6	22. Price

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Successful industrial and economic mastery of regions in the Far North is not possible without solving major medical-biological problems, especially adaptation problems. Over many generations inhabitants developed adaptation mechanisms and the human organism adjusted to such extreme factors as cold, difficult aerodynamic conditions, specific photoperiodism, geomagnetic field fluctuations, etc. Human populations which developed adaptation mechanisms to specific characteristics of the ecology in the Far North may turn out to be more or less resistant to the many influences of scientific and engineering progress. Therefore the complex program entitled "Man's Adaptation" elaborated in the Siberian branch of the USSR Academy of Medical Sciences includes a study of adaptation mechanisms of the native and migrant population in Far North regions on various levels, starting with the sub-molecular level and ending at the population level.

One current trend is the study of oxygen conditions in the native and migrant population as they determine the character and level of energy processes in the organism. Many investigators reported that new settlers in Northern regions frequently complain of shortness of breath under light physical stress. The latter was even given the name polar dyspnea. According to the latest data by A. P. Avtsyn and his collaborators, the appearance among inhabitants residing at high latitudes of adaptation-compensatory reactions of functional systems responsible for oxygen conditions directed to "struggle for oxygen" may be called the circumpolar hypoxia syndrome.

An understanding of the causes of such "Northern hypoxia" must be based on a study of basic systems participating in the transport and utilization of oxygen. This was the purpose of our studies carried out in Norilsk, the Dixon settlement, Yakutsk and other regions. On one hand we evaluated indicators of the external respiration function, and on the other, using the Micro-Astrul instrument we determined oxygen pressure in arterial and venous blood and acid-base equilibrium indicators. The relationship between the main forms of hemoglobin was investigated. Some indicators of lipid exchange were analyzed (common lipids, cholesterol, triglycerides, antioxidant activity) and also a number of physical chemical properties of erythrocyte membranes.

The investigations revealed that the external respiratory function in the migrant population differs considerably from the corresponding norm among natives of Novosibirsk inhabitants. Maximal breathing capacity, vital capacity, expiratory reserve volume and respiration reserve decrease significantly along with an increase in breathing capacity per minute.

Another indicator of oxygen pressure conditions in the organism under high latitude conditions is the erythron function which manifests itself in more intense erythropoiesis, increased volume and thickness of the erythrocyte without a change in its diameter.

In the Yakutsk region, an increase in the content of F hemoglobin and methemoglobin was detected in the native population and their levels exceeded the Novosibirsk norm. While an increase in the F hemoglobin concentration in the blood can be considered as an adaptation reaction directed towards combatting hypoxia, the increase in the methemoglobin concentration in whole blood is still not understood. The greatest decrease in oxygen content in venous blood was noted

among people who have lived in Zapolyarye for two years or longer. Such shifts resulted in an increase in the arterial-venous oxygen difference among these people. A shift in acid-base equilibrium toward metabolic acidosis has also been observed in them.

The causes for the change in the oxygen conditions of the organism detected by us and by other investigators in the migrant Zapolyarye population are still not sufficiently clear. Only general concepts pertaining to possible causes of the change of oxygen conditions in the organism in the Far North can be stated.

At the present time it is well known that besides fermentative oxidation of substrates, for example, unsaturated fatty acids, a non-fermentative free-radical oxidation path exists in a cell. The products which are formed are toxic for a cell and they pervert microsomal and mitochondrial oxidation processes which regulate oxygen conditions in the cell and apparently of the whole organism.

Our research in the Far North has shown that a reduction in lipid antioxidants is observed in the migrant population, i.e. substances hindering the development of free radical lipid oxidation reactions. A reduced concentration of antioxidants and a change in the intensity of free radical lipid oxidation reactions and also the changes in physical chemical properties of biological membranes related to these reactions and the directivity of oxidation processes are apparently one basic factor influencing oxygen conditions in the organism in the Far North.

The chronic stress manifest in men in these regions, named by V. P. Kaznacheyev in 1974 the polar stress syndrome, is not a pathological state. It reflects the adaptation of

the organism to extreme factors in the environment.

We think that the application of antioxidants (tocopherol) and substances potentiating their action (methionine, ascorbic acid) is expedient in the complex therapy of various diseases in men in Far North regions and also in their prevention.

TM-75391